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Phytotoxicology Assessment Investigation in the Vicinity of Hay Battery, 1 Dunbar Avenue, Hamilton - 1991.

Phytotoxicology Section
Air Resources Branch

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Background

Lynn Kergan of the Environment Ministry's Hamilton District Office, West Central Region, requested that the Phytotoxicology Section conduct a soil survey in the vicinity Hay Battery, 1 Dunbar Avenue, Hamilton. The company manufactures and rebuilds wet-cell batteries.

In response to the request, Mr. G. Vasiloff of the Phytotoxicology Section conducted a soil survey in the vicinity of Hay Battery on 27 August 1991. The Hay Battery company is located in a mixed urban residential, commercial and industrial area. Although there are other small industrial and commercial enterprises in the immediate area, the Dofasco steel company complex dominates virtually all the property north and northwest of Hay Battery. A variety of other heavy industries are located to the northeast and east of the battery company.

Subsequent to the 1991 survey, it was learned that the Phytotoxicology Section had been involved in vegetation and soil surveys during the early 1970s around the former location of Hay Battery on Barton Street. According to a 1973 memorandum[1] the Hamilton M.O.E. office had requested that a soil and vegetation study be conducted in the vicinity of Hay Battery at their original location at 1300 Barton Street East, Hamilton. In response to that memo, an initial survey of vegetation and soil was conducted in 1973 at 3 locations near the original Hay Battery site. The report indicated that vegetation and soil samples contained lead concentrations that were within the Upper Limit of Normal (ULN) guidelines in effect at that time.[2]

A second Phytotoxicology Hay Battery survey was conducted on 29 October 1974. Vegetation and soils were collected at both the original Hay Battery location on Barton St. and the new location on Dunbar Avenue. Surveys at both locations were conducted because the company moved from Barton St. to their new location on Dunbar Avenue in early August of 1974. With respect to contamination guidelines in effect at that time, excessive

concentrations of lead were detected in vegetation and soil at 2 of 3 sample locations near the former Hay Battery site on Barton Street. At sites close to the Dunbar Avenue location, lead concentrations in vegetation and soil were below ULN guidelines.[3]

Based on archival Phytotoxicology files, vegetation and soil was sampled at the request of a resident of Newlands Avenue. The property was located behind the Barton Street location formerly occupied by Hay Battery. Concentrations of lead in Chinese elm and lilac foliage exceeded the 1975 guideline of 150 ppm. In 0-5 cm soil sampled on the property, the lead concentration was 775 ppm, and 668 ppm in 5-10 cm soil.[4]

In 1975, another Phytotoxicology survey was conducted in the vicinity of Hay Battery at their new Dunbar Avenue location. Vegetation only was sampled at 3 sites near the factory. Lead concentrations detected in Manitoba maple foliage were below the 1975 guideline of 150 ppm (the 1991 ULN guideline for lead is 60 ppm in urban foliage). At one site immediately north of Hay Battery, the lead concentration in the foliage was 122 ppm.[5]

1991 Phytotoxicology Soil Survey

Triplicate samples of 0-5 cm soil were collected at 10 survey sites in the vicinity of the Hay Battery location at 1 Dunbar Avenue. Control soils were collected at Site 12, located within an urban residential location at 146 Adeline Street. Locations of all soil survey sites are shown in the attached Figure. None of the 1991 survey sites had been sampled in the Phytotoxicology surveys of 1973, 1974 or 1975.

All samples were returned to the Phytotoxicolgy laboratory in Toronto for pre-analysis processing according to a standardized method[6]. Processed samples were submitted to the Ministry's Inorganic Trace Contaminants Laboratory for analysis of 14 inorganic elements.

Chemical Analysis Results

The concentrations of lead and 13 other inorganic elements detected in soils collected in the vicinity of Hay Battery appear in Table 1. The values in the table are means of the triplicate sample analyses. The Phytotoxicology Upper Limit of Normal (ULN) guidelines for each of the elements is included. Concentrations in the table that exceed ULN guidelines have been underlined. The attached appendix provides the rationale behind the derivation and significance of the ULN guidelines.

Lead

Concentrations of lead at all 10 survey sites were below the ULN guideline of 500 ppm for 0-5 cm urban soils. The highest concentration (307 ppm) was found at Site 8, approximately 125 metres northwest of Hay Battery. Although lead levels at all 10 sites were below ULN guidelines, all were elevated in relation to the control.

Copper

Copper concentrations at 9 of 10 sites were below the ULN guideline but slightly elevated compared to the control value. At Site 8, however, the copper concentration of 107 ppm exceeded the 100 ppm ULN guideline. This sample site is a well kept rear residential lawn area situated very close to Kenilworth Avenue, a busy rail line and Hay Battery. Although the copper value at the location exceeded the ULN guideline, the concentration should not be cause for concern with regard to toxicity to vegetation. The 107 ppm found in the soil at Site 8 is below the Ministry's recommended clean-up guideline for copper (<200 ppm) in industrial land slated for residential redevelopment[7].

Manganese

Manganese concentrations in excess of the ULN guideline of 700 ppm were detected in soils at Sites 2, 6, 8, 9 and 11. Although excessive concentrations were found at these sites, it should not be concluded that the contamination occurred as a result of exposure to an industrial manganese source. The ULN guideline is currently under review because of the high variability of this element that occurs naturally in soil. Manganese concentrations in the range found at Sites 2, 6, 8, 9 and 11 are frequently encountered in both urban and rural soil that has not been exposed to a known manganese source.

Other Elements

Although concentrations of zinc, cadmium, nickel, molybdenum, vanadium, chromium, cobalt, aluminum, strontium, iron and sodium in the sample soils were all below ULN guidelines, many of the elements were elevated with respect to control values and proximity to Hay Battery. In addition to lead and copper, the highest concentrations of nickel, strontium and sodium also occurred at Site 8.

Electrical Conductivity and pH of Soil

Results of electrical conductivity and pH tests performed on the survey soils appear in Table 2. Electrical conductivity (EC) measures the concentration of soluble salts in the soil. The higher the soluble salt concentration, the higher the EC. Tests for pH indicate the acidity or alkalinity of soils. The pH scale is from 0-14. Values below 7 are considered acidic while those above are alkaline.

The pH test results of the survey soils indicate that all values are within a normal range. With respect to electrical conductivity values of the survey soils, soluble salt concentrations were low and within the range that should be suitable for most plants.

Summary

Elevated, but not excessive, concentrations of lead were detected in soils sampled at sites close to the Hay Battery facility. Soil lead concentrations were highest at Site 8, which is the site closest to the source. At this same location, the copper concentration exceeded the ULN guideline. In addition to lead and copper, concentrations of nickel, strontium and sodium were found to be most elevated at this site.

Excessive concentrations of manganese were found at 6 of 10 sample sites, however, there is no apparent relationship between the high concentrations and the battery operation. High manganese concentrations are frequently encountered in urban and rural soil that has not been exposed to a known manganese source. As a result, the current ULN guideline for manganese is under review.

Although Hay Battery emissions may be the cause of the elevated or excessive lead, copper, nickel, strontium and sodium concentrations at Site 8, the presence of other industries in the area makes it difficult to distinguish the pollution source with confidence.

TABLE: 1 Concentrations[1] of 14 Inorganic Elements in 0-5 cm Soil Collected in the Vicinity of Hay Battery, 1 Dunbar Avenue, Hamilton - 1991

Survey Site Number	Distance & Direction from Hay Battery	Concentration (ppm - dry wt)							
		Pb	Zn	Cd	Ni	Cu	Mo	V	Cr
1	175 m ESE	157	267	1	21	52	<0.2	31	28
2	325 m ESE	167	473	2	27	51	<0.3	38	34
3	550 m ESE	60	327	1	17	39	<0.2	28	22
4	425 m SE	98	223	1	22	37	<0.2	33	42
5	225 m SE	75	220	1	19	39	<0.4	33	25
6	150 m S	70	147	1	14	37	<0.2	30	25
7	325 m SSW	95	157	1	21	40	<0.7	32	27
8	125 m NW	307	470	2	31	107	<0.5	37	37
9	350 m NW	117	263	2	23	49	<1.1	38	38
11	600 m NW	103	227	1	22	42	<0.2	38	33
12 (Control)	1.8 km SE	25	69	<1	13	22	<0.2	29	18
Phytotoxicology Upper Limit of Normal (ULN) Guidelines for 0-5 cm urban soil.		500	500	4	60	100	3	70	50

[1]Data are averages of triplicate sample analyses.

cont'd....

TABLE: 1 (cont'd)

Survey Site Number	Distance & Direction from Hay Battery	Concentration (ppm - dry wt) Co	Mn	Al (%)	Sr	Fe (%)	Na
1	175 m ESE	7	647	1.5	36	2.0	102
2	325 m ESE	9	787	1.8	51	2.3	133
3	550 m ESE	5	587	1.2	42	1.6	117
4	425 m SE	8	637	1.5	38	2.3	120
5	225 m Se	7	630	1.4	42	2.0	113
6	150 m S	5	903	1.2	41	1.8	120
7	325 m SSW	8	687	1.5	31	2.1	96
8	125 m NW	9	797	1.7	67	2.1	150
9	350 m NW	9	947	1.6	50	2.8	130
11	600 m NW	8	773	1.6	35	2.6	133
12 (Control)	1.8 km SE	6	523	1.1	19	1.8	82
Phytotoxicology Upper Limit of Normal (ULN) Guidelines for 0-5 cm urban soil.		25	700	NE	NE	3.5%	NE

Aluminum and iron results are percent (%) - dry weight.

Underlined data exceed the ULN guideline.

NE - ULN guideline has not been established for this element.

Table: 2 Electrical Conductivity and pH of 0-5 cm Soils Collected in the Vicinity of Hay Battery, 1 Dunbar Avenue, Hamilton - 1991

Survey Site Number	Distance & Direction from Hay Battery	Electrical Conductivity	pH
1	175 m ESE	0.27	6.38
2	325 m ESE	0.31	6.32
3	550 m ESE	0.35	5.83
4	425 m SE	0.31	6.26
5	225 m SE	0.36	6.56
6	150 m S	0.24	5.68
7	325 m SSW	0.29	6.26
8	125 m NW	0.33	6.56
9	350 m NW	0.27	6.13
11	600 m NW	0.30	6.53
12 (Control)	1.8 km SE	0.26	6.70

Electrical Conductivity in millisiemens/cm.

Data are average of triplicate analysis.

INTERPRETATION OF ELECTRICAL CONDUCTIVITY VALUES

Conductivity Reading	**Rating**	**Plant Response**
0 - 0.25	L	Suitable for most plants.
0.26 - 0.45	M	Suitable for most plants.
0.46 - 0.70	H	May reduce emergence and cause slight to severe damage to salt sensitive plants.
0.71 - 1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

REFERENCES

1 **Request for Preliminary Study of Lead Content of vegetation and Possibly Soil in the Vicinity of Hay Battery (1970) Ltd, 1300 Barton St. East, Hamilton.** Memo from J.G. Fry to G.S. Trivett. August 16, 1973.

2 **Results of 1973 Vegetation Surveillance Around Ram Solder Co. and Hay's Battery, Hamilton.** Ontario Ministry of the Environment, Toronto.

3 **Phytotoxicology Lead Assessment Study: Hay Battery, Hamilton.** Ontario Ministry of the Environment, Toronto. March 10, 1975.

4 Report of D.S. Harper, Ontario Ministry of the Environment, March 4, 1975.

5 **Vegetation Lead Survey 1975: Hay Battery, Hamilton.** Ontario Ministry of the Environment, Toronto. May 20, 1976.

6 **Procedure Manual for Vegetation and Soils Processing Laboratory.** (Draft) Ontario Ministry of the Environment, Phytotoxicology Section, Air Resources Branch, Toronto.

7 **Soil Clean-Up Guidelines for Decommissioning of Industrial Lands: Background Rationale for Development.** Ontario Ministry of the Environment, Phytotoxicology Section, Air Resources Branch, Toronto. March, 1991.

APPENDIX

Derivation and Significance of MOE "Upper Limits of Normal" Contaminant Guidelines

The MOE "upper limits of normal" contaminant guidelines essentially represent the expected maximum concentration of contaminants in surface soil (non-agricultural), foliage (tree and shrub), grass, moss bags and/or snow from areas of Ontario not subject to the influence of point source emissions. "Urban" guidelines are based upon samples collected from centres of minimum 10,000 population. "Rural" guidelines are based upon samples collected by MOE personnel using standard sampling techniques (ref: Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section - Air Resources Branch: Technical Support Sections - NE and NW Regions). Chemical analyses were performed by the MOE Laboratory Services Branch.

The guidelines were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. For those distributions that are "normal", 99% of all contaminant levels in samples from "background" locations (i.e. not affected by point sources nor agricultural activities) will lie below these upper limits of normal. For those distributions that are non-normsl, the calculated upper limits of normal will not actually equal the 99th percentile, but nevertheless they lie within the observed upper range of MOE results for Ontario samples.

It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case by case basis to determine the significance, if any, of the above normal concentration(s). Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations which are below the guidelines are not known to be toxic.

Map Showing Soil Survey Sites in the Vicinity of Hay Battery,
1 Dunbar Avenue, Hamilton - 1991.